REV A

DWG NO. 201027456

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TITLE

Low Hydrogen Embrittlement Plating Process Specification Zinc – Nickel (Gamma Zn)

SIZE	CAGE CODE	DWG NO.	REV
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SHEET 1 OF 24

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TABLE OF CONTENTS

LIST OF FIGURES

No table of figures entries found.

LIST OF TABLES

No table of figures entries found.

1 SCOPE

1.1 Purpose

This specification covers the process and materials required for the electro-deposition of a Low Hydrogen Embrittling (LHE) zinc-nickel alloy on high strength steel substrates. Subsequent heat treating techniques needed to ensure low embrittlement of steel are also described. The process can also be used on lower strength steel alloys, corrosion resistant steel alloys, and copper based alloys.

1.2 Application

Alkaline, cyanide free LHE zinc-nickel electroplating meeting this specification is a substitute for cadmium as a corrosion control coating. However, it will not be used without authorization from the applicable procuring agency. This process is non-embrittling to high strength steels and can meet the requirements for a non-embrittling process per ASTM F 519. The process also has excellent throwing power and covering power. The deposit consists of a uniform zinc alloy containing nickel at typically 12 - 15%. It has excellent heat and corrosion resistance, especially in high temperature applications.

1.2.1 Qualification

Qualified products will appear on the Source Control Drawing 201027457. Product specific information shall be found in the appendices.

1.3 Classification

LHE Zinc-nickel plating covered by this specification shall be of the following classes:

Class 1	0.013mm (0.0005 inch) thick minimum
Class 2	0.008mm (0.0003 inch) thick minimum
Class 3	0.005mm (0.0002 inch) thick minimum

Note: Unless otherwise specified, the maximum thickness for each class shall be 0.0076mm (0.0003 inches) greater than the minimum for the class.

1.3.1 Types

Plating covered by this specification is classified as follows:

Type I	As-plated without supplementary treatment
Type II	As-plated with supplementary chromium conversion coat treatment.

1.4 Safety – Hazardous

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and

proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2 APPLICABLE DOCUMENTS

The following publications form a part of this specification to the extent specified herein. The applicable issue of all publications shall be the issue in effect on the date of the purchase order unless otherwise specified.

2.1 Government Documents

2.2 Specifications, Standard, Handbooks, and Commercial Item Descriptions

The following specifications, standards, handbooks, and commercial item descriptions form a part of this document to the extent specified herein.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1504	Abrasive Blasting of Aircraft Components
MIL-STD-865	Selective, Brush Plating, Electro Deposition
MIL-STD-1916	DOD Preferred Methods for Acceptance of Product

2.3 Non-Government Publications

The following documents form a part of this document to the extent specified herein.

AMS 2451/9	Plating, Brush, Zinc-Nickel Low Hydrogen Embrittlement

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM F 519	Hydrogen Embrittlement Evaluation of Plating Processes & Service Environments
ASTM B 568	Measurement of Coating Thickness by X-Ray Spectrometry
ASTM E 376	Measuring Coating Thickness by Magnetic-Field or Eddy Current (Electromagnetic) Examination Methods
ASTM B160	Standard Specification for Nickel Rod and Bar
ASTM D1193	Standard Specification for Reagent Water
ASTM B117	Standard Practice for Operating Salt Spray Apparatus
ASTM D3359	Paint Adhesion Testing

(Copies of this document are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of Precedence

In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document; however, supersedes applicable law and regulations unless a specific exemption has been obtained.

3 GENERAL REQUIREMENTS

3.1 General

This section covers the materials and equipment required to accomplish the described process. Reference detailed requirements in the applicable appendix.

3.2 Materials and Equipment

3.3 Materials

a. Refer to the applicable appendix for the materials required for the process.

3.4 Equipment

3.4.1 Current

Either generated or rectified D.C. current may be used. Ripple value shall not exceed 5 percent as measured by dividing the Root Mean Square of the A.C. voltage component by the D.C. voltage.

3.4.2 Processing Tanks

Tanks shall be resistant to the operating temperature and the chemical environment. Tanks in which any electrolytic action is taking place must be free of electrical shorts. Tank must be electrically insulated. Reference equipment in the applicable appendix.

3.4.2.1 Transferring Solution

If transferring solution outside of plating tank is required for repair or maintenance, all associated equipment used including pumps, hoses, holding tanks etc. shall be chemically compatible with the solution.

3.4.3 Tank Temperature

Processing tanks to be operated at temperatures other than room temperature shall be equipped with automatic temperature indicating and regulating devices.

3.4.4 Measuring Current

An ammeter shall be placed in series with the LHE zinc-nickel tank cathode. The ammeter shall have sufficient shunts and switches to provide a full-scale reading equal to the maximum capacity of the power source, and an accuracy of ± 10 percent of the current being measured.

3.4.5 Blast Cabinets

A blast cabinet shall be located near the plating line. The size of the cabinet shall be adequate to enclose the parts to be plated. Air lines shall be suitably trapped and filtered to prevent in-process contamination of the parts to be cleaned.

3.4.6 Ovens

An oven capable of baking parts at 190.5 ± 13.9°C (375 ± 25°F) shall be located near the plating line. The size of the oven shall be adequate to enclose parts to be plated. The oven shall be equipped with temperature indication, recording, and regulating devices.

3.4.7 Conformal Anode

Conformal anodes shall be designed, verified and validated for every component requiring fixturing and anoding to insure uniformity of plating. The anodes shall be manufactured of solid nickel for appropriate plating transfer without the potential of contamination

3.5 Embrittlement (Reference 5.5.5)

Qualification test specimens and process control test specimens shall be subjected to a sustained load test at 75 percent of the ultimate notched tensile strength. The specimens shall endure this sustained load for 200 hours minimum without failing or cracking.

3.6 Re-processing

Parts rejected for defective plating, requiring stripping and re-plating, shall include all of the pre-plating steps of this standard.

3.7 Pre Plate Stress Relief

Steel parts having an ultimate tensile strength of 180,000 psi or greater and which have been machined, ground, formed, or straightened after heat treatment, shall be stress relieved in accordance with instructions from the procuring agency. Stress relief shall precede shot peening, cleaning, and plating. Stress relief is not required for fasteners if all cold working is limited to cold working of the head-to-shank fillet and thread rolling after heat treatment.

3.8 Contact Points

Electrical contact between the parts and power source shall be made to prevent chemical or immersion deposition, electrical arcing, and overheating. If parts are to be plated all over, contact points shall be specified by the customer or minimized in the absence of said direction. Any contact points that have an area greater than a quarter inch diameter shall be brush plated. If parts are not required to be plated all over, contact points shall be located on areas on which plating is not required or is optional. This shall apply only if such contact point will not damage a functional surface (such as chromium plated or machined surface).

3.9 Brush Plating

Parts or areas that require brush plating shall be processed in accordance with (IAW) the latest revision of AMS 2451/9 and as directed by the purchaser using non-embrittling zinc-nickel products. Non-embrittling products shall be listed in Source Control Drawing 201027457 or shall be approved by the purchaser.

4 TECHNICAL REQUIREMENTS

This section provides the detailed requirements to accomplish the plating process identified in this standard.

4.1 Plating Strike

For low carbon steels, the LHE zinc-nickel shall be deposited directly on the base metal. A strike or pre-plate of an alternate metal is not allowed. A short duration high current density strike in the LHE zinc-nickel plating solution is allowed prior to plating at lower current densities.

4.2 Prior to Plating

Prior to plating, all machining, forming, welding, and shot peening shall be completed.

4.3 Plating Sequence/Baking

Unless otherwise specified parts heat treated to 180,000 psi ultimate tensile strength and above shall be baked following plating for 23 hours minimum at 190.5 ± 13.9°C (375 ± 25°F) within 4 hours of plating. If chromium and LHE zinc-nickel are used in combination, the chromium shall be deposited first. When chrome plating is to be followed by LHE zinc-nickel plating, the 23 hours minimum bake following chrome plating can be replaced by a four (4) hour bake at 190.5 ± 13.9°C (375 ± 25°F) provided the part will be baked for 23 hours minimum after completion of the LHE zinc-nickel plating.

Interruptions for loading and unloading parts shall be permitted provided the time between the opening of the furnace door, and the re-establishment of the specified baking temperature, is not used to determine the total cumulative bake time. A maximum of 30 minutes shall be allowed for a bake interruption for loading and unloading parts. Anything longer than this shall be considered a process failure and the parts shall be subjected to engineering review. The specified baking temperature shall be considered to be re-established when all control, indicating and recording thermocouples reach the specified baking temperature.

4.4 Storage of Parts

Storage of parts between stress relief and cleaning shall be controlled to prevent contact with water or other corrosive materials. Parts shall be stored to permit free circulation of air around the parts.

4.5 Handling of Parts

After the parts have been cleaned prior to plating, they shall be handled in a manner that will ensure that contamination is minimized.

4.6 Masking

Sections or areas of a part that are not to be plated shall be masked. Plugging and masking materials which do not contaminate the plating bath shall be used. Masking shall be performed at the most convenient step prior to plating.

4.7 Conformal Anode/Fixturing

The use of fixturing with conformal anodes shall be required unless analysis or prototype plating demonstrates that conformal anodes are not required for uniform plating. Sufficient contact area and pressure shall be provided to carry the current without overheating. Racking should be performed at the most convenient step prior to plating.

4.8 Procedure

For procedures see the appendix appropriate to the chemistry being used.

4.9 Post Plating Treatment

4.9.1 Types of Treatment

Refer to applicable directives for type of treatment. If the type of treatment is not specified, the part shall be given the Type II treatment.

Type I	No post plating treatment required
Type II	Chromium conversion coat (See: section 4.9.2)

4.9.2 Type II

Parts which specify Type II treatment shall be given a supplementary conversion coating which will meet the requirements of 5.5.2. Hexavalent chromium conversion coatings are typically required to be applied after post plate thermal treatments. Refer to technical literature to determine if other conversion coatings can be applied prior to post plate thermal treatment. Steel parts requiring a post plate thermal treatment as in 4.3 may require reactivation prior to application of the conversion coating.

4.10 LHE Zn-Ni Stripping Procedure

The LHE Zn-Ni coating can be stripped in a solution of ammonium nitrate at 32 ounces per gallon in water. Stripping times should be 30 to 60 minutes at a temperature of 21 – 27 °C (70 – 80 °F) depending on the condition of the strip solution and the thickness of the coating. Additional ammonium nitrate may be added as necessary to maintain the stripping rate.

Alternately, an ammonium nitrate solution of 16 ounces per gallon in water with the pH maintained at 8 to 9 using sodium hydroxide may be used. This solution may strip somewhat faster than the 32 ounce per gallon solution but the solution life is significantly shorter. The ammonium nitrate additions discussed above also apply to this solution.

5 QUALITY ASSURANCE PROVISIONS

5.1 Responsibility for Inspection

Unless otherwise specified, the contractor is responsible for the performance of all inspection requirements. The contractor shall furnish all test samples required for the completion of all inspection/test requirements. The contractor may use his own or any other facility to perform the inspection requirements unless disapproved by purchaser. The contractor shall maintain all documentation relating to the inspection requirements for not less than seven years. The purchaser reserves the right to perform any of the inspections in this document to insure compliance. Successful performance of these inspection requirements does not authorize the contractor to submit known defective product. Nothing in this document shall relieve the contractor from the responsibility to comply with all requirement of the contract

5.2 Required Testing

5.2.1 Required Tests

These are listed by test and requirement paragraph. See the applicable appendix for any additional tests required for a specific plating chemistry:

Thickness (paragraph 5.5.1)
Corrosion resistance, Type II (5.5.2)
Adhesion (5.5.3)
Finish Quality (5.5.4)
Hydrogen embrittlement (5.5.5)
Re-Qualification (5.5.6)
Processing bath chemistry (5.5.7)

5.3 Quality Inspection Criteria

5.3.1 Quality Inspection Interval

Unless otherwise specified, the Finish Quality inspection (paragraph 5.5.4) shall be performed on every part. Thickness shall be performed on random parts (not less than 1 per lot) in accordance with a sampling plan from the supplier and approved by the purchaser. All other inspection requirements shall be performed at least once every 30 days. The supplier may define more frequent testing in local process instructions. Testing shall demonstrate continued compliance of the process with the requirements of this specification.

5.3.2 Lot Sampling

As an alternate to the requirements of 5.3.1 and as agreed on between the purchaser and contractor, individual inspection requirements for product produced in lots may be inspected using a lot sampling plan in accordance with MIL-STD-1916. A lot shall be defined as all parts of the same material and part number or similar part configuration, plated to the same range of deposit thickness, using the same solutions, plated in a single continuous plating cycle not to exceed 16 hours, and presented for processor's inspection at one time.

5.3.3 Destructive Testing

If destructive testing is required, such testing shall be based on a test plan approved by the purchaser.

5.3.4 Alternative Inspection Plan

The contractor may propose an alternate inspection plan for consideration by the purchaser. If approved, such plan will supersede the preceding.

5.4 Preproduction Tests

All of the requirements of this drawing are also preproduction requirements and shall be complied with prior to producing any production parts.

5.5 Test and Sample Requirements (reference 5.3.1 for test frequency)

Test specimens shall be processed the same as production parts. Test specimens shall not be re-used.

5.5.1 Thickness

Shall be determined by non-destructive methods on actual production parts in three separate areas and shall meet the requirements for the part being tested. Thickness shall be determined in accordance with ASTM B 568, ASTM E 376, or other method acceptable to purchaser which may include destructive testing.

5.5.2 Corrosion Resistance

Shall use separate test panels. The panels shall be 4130 steel approximately 1.0 x 102 x 153 mm (0.040 x 4 x 6 inches). A minimum of 2 test panels shall be used for each test. Coating thickness shall be determined for each test panel using the same test procedure as used on production parts. Test panels shall be plated to Class 2 thickness. The test panels shall meet the following criteria:

5.5.2.1 Type II

Coatings shall show no evidence of white corrosion products after 96 hours when tested by continuous exposure to the salt spray in accordance with ASTM B 117. Areas within 6.35 mm (0.25 inches) from the edges of the panel, the identification markings, and the panel holding points during processing or salt spray exposure shall not be evaluated. Test panels shall be retained for a minimum of 1 year.

5.5.3 Adhesion

The panels shall be 4130 steel approximately 1.0 x 25 x 102 mm (0.040 x 1 x 4 inches). A minimum of 2 test panels shall be used for each test. Test panels shall be plated to Class 1 thickness. They shall then be clamped in a vise and repeatedly bent through 90 - 180 degrees until fracture of the base metal occurs then examined at 4X magnification for lifting of the deposit along the fractured edge. Crazing of the deposit is acceptable, but flaking off or lifting of the deposit shall constitute failure. Test panels shall be retained for a minimum of 1 year.

5.5.4 Finish Quality

This is a visual examination of the part after it has completed the plating process. The deposit shall be smooth, continuous, adherent to the basis metal, and visually free from porosity, blisters, nodules, pits, and other imperfections detrimental to performance of the plating. Slight staining or discoloration is permissible.

5.5.5 Hydrogen Embrittlement Relief Test

5.5.5.1 Initial Qualification Embrittlement Test (or as required by 5.5.6)

The processor shall demonstrate the ability to provide a LHE zinc-nickel plate which meets the requirements of paragraph 3.5 of this drawing as follows:

a. Four round notched 4340 steel specimens per ASTM F 519, Type 1a.1 or 1a.2 shall be prepared.

b. The specimens shall be prepared and plated in accordance with all of the requirements of this standard. During plating the specimens shall be mounted symmetrically on a rack by themselves. All areas of the rack except the contact area shall be coated with a suitable maskant. An ammeter having a sensitivity of ±10% of the current required and shall be connected between the specimen rack and the cathode. The specimens shall be plated at 4.4-4.9 A/dm^2 (40-45 $amps/ft^2$) to insure a plating weight range of 0.011 - 0.015 g/cm^2 (0.073 - 0.097 g/in^2). The specimens shall be baked for 23 hours minimum at 190.5 ± 13.9°C (375 ± 25°F) within four (4) hours of removal from the bath.

c. The specimens shall be subjected to a minimum 200 hours of static loading at 75 percent of the ultimate notched tensile strength in accordance with ASTM F 519. The test shall be considered passed if all four (4) specimens meet the requirements of paragraph 3.5.

d. Upon successful completion of the static load test, one of the notched tensile specimens shall be sectioned across the notch parallel to the axis of the specimen. Photomicrographs shall be taken of the notched area and the coating examined at 80 – 100 X magnifications. The coating shall be uniform around the circumference of the notch and the coverage essentially complete. Consideration must be given to the nature of the coating. The coating, under magnification, is rough. There will be voids that may extend to base metal. This shall not be considered as incomplete plating.

e. A complete analysis report of the plating bath with the qualification test results shall be submitted as required by the procuring activity.

5.5.5.2 Re-qualification

Any significant change to the solution shall require re-qualification. (Reference 5.5.6)

5.5.5.3 Process Control Embrittlement Acceptance Test

Once the process has been qualified in accordance with 5.5.5.1 and 5.5.5.2, process control testing shall be accomplished at least once every 30 days as follows:

a. Two standard specimens of the type noted in paragraph 5.5.5.1a, shall be prepared and processed in accordance with 5.5.5.1b, c, and d. Failure of any one of the specimens shall constitute failure of the test and production shall cease until the cause of the failure is determined and the bath is re-qualified. Acceptance of items completed after the last successfully completed acceptance test shall be withheld until the extent and cause of the failure has been determined.

b. The test for embrittlement shall be conducted as often as deemed necessary with the maximum interval of every 30 calendar days. If the embrittlement test has not been performed in the 30 days preceding the processing of the material batch the bath must be re-qualified in accordance with paragraph 5.5.5.1.

5.5.6 Re-qualification – All Physical & Chemical Tests

Any significant change in the solution shall require re-qualification of all tests in section 5.5. Examples of significant changes are, but not limited to, new solution makeup, removal of 20% or more of the solution with the accompanying addition of new make-up chemicals, storage of the solution for seven days or more outside of the process tank, shutdown of the process for 30 days or more, and suspected or known contamination and subsequent treatment to remove such contamination. The contractor must determine if other possible events qualify as significant with the understanding that the contractor shall not present for acceptance by the purchaser any part processed in a known or suspected deficient process solution. The following shall not be considered significant changes: removal from the process tank to batch "freeze" for carbonate removal (unless left for seven days or more or contamination occurs), in-tank dummying to remove metallic contamination, continual circulation outside of the process tank for carbon treatment, filtration, and carbonate treatment.

5.5.6.1 Re-qualification Non Use

If the process will not be used for greater than 30 days the contractor shall continue quality testing per this standard. Alternatively testing can be discontinued during non use provided that the contractor fully re-qualifies the solution per section 5.5 prior to resuming production plating.

5.5.6.2 Re-qualification Solution Maintenance

If the solution was removed for tank maintenance, repair etc. then returned prior to 7 days re-qualify per section 5.5.5.3a.

5.5.7 Processing Bath Chemistry

Shall be determined in accordance with the requirements of the chemistry being used (see the appropriate appendix). Testing shall be accomplished on a

frequency sufficient to assure the process is in tolerance during processing of parts.

5.6 Changes

The processor shall make no change to materials, processes, or controls from those on which the approval was based, unless the change is approved by the cognizant engineering organization or unless the change results in tighter control of the process.

5.7 Re-sampling and Retesting

5.7.1 Acceptance Test Failure

a. If the results of any lot test (paragraph 5.3.2) fails to meet the specified requirements, the parts represented shall be stripped by a method acceptable that does not roughen, pit, or adversely affect part dimensions. They shall then be pretreated, coated, supplementary treated if specified and as defined herein, and tested. Alternatively, all parts in the lot shall be inspected for the nonconforming attribute. The nonconforming parts shall be stripped and reprocessed as above.

b. If the results of any test performed at the intervals specified in 5.3.1 fail to meet the specified requirements, the process is nonconforming. No part shall be coated until the process is corrected and new specimens are coated and tested with acceptable results. Results of all tests shall be recorded, and when requested, reported.

c. In either of the cases in 5.7.1a and 5.7.1b above, the represented parts shall receive a hydrogen embrittlement relief bake in accordance with paragraph 4.3 within 4 hours of plating

6 PREPARATION FOR DELIVERY

6.1 Packaging

Plated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the plate are preserved.

6.2 Shipping

Packages of plated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.

7 ACKNOWLEDGMENT

Processor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

8 REJECTIONS

Parts, which have LHE Zn-Ni plating that does not conform to this specification, or to modifications authorized by purchaser, shall be subject to rejection.

9 NOTES

This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.

9.1 Procurement Documents

Should specify not less than the following:

- This drawing number
- Plating type
- Plate thickness desired
- Method for determining plating thickness
- Quality sampling plan if different from the requirement in Sections 5

9.2 Threaded Components

Use caution when torquing threaded components. Use an approved lube to maintain proper toque tension relationships.

APPENDIX 1

Dipsol IZ-C17+ LHE Zinc-Nickel PLUS with IZ-264 Trivalent Chromium Conversion Coating

1 CHEMICALS FOR SOLUTION MAKEUP AND MAINTENANCE

1.1 Proprietary Note

With the exception of sodium hydroxide, nitric acid, and hydrochloric acid, the chemicals used to make up and maintain plating and conversion coating solutions are proprietary products of Dipsol of America. Additional information may be obtained from the Dipsol technical bulletins. However, if there is a conflict between the technical bulletin and this document, this document shall take precedence.

1.2 Chemicals for Makeup IZ-C17+

Chemicals for makeup and maintenance of the IZ-C17+ zinc-nickel plating solution:

a. IZ-C17+MS, concentrate for solution makeup.

b. IZ-C17+NI, concentrated nickel solution for replenishment of nickel.

c. IZ-C17+B, nickel stabilizer.

d. NZ-777, concentrated zinc solution for replenishment of zinc.

e. F-0529, water conditioner additive.

f. Sodium hydroxide meeting the chemical composition requirements of MIL-STD-612C, Table XX for 50% Rayon Grade solution or Table XXV for solid Rayon Grade. MIL-STD-612C has been cancelled without replacement. The referenced tables can still be used to specify the quality of the sodium hydroxide.

1.3 Chemicals for Makeup IZ-264

Chemicals for makeup and maintenance of the IZ-264 trivalent chromium conversion coat solution:

a. IZ-264, concentrate containing cobalt for makeup and maintenance.

b. IZ-264T, concentrate containing trivalent chromium for makeup and maintenance.

c. Nitric acid, 61.0 to 68.2 % w/w nitric acid per specification A-A-59105.

d. Sodium hydroxide meeting the requirements in paragraph 1.2f.

1.4 Municipal Water Makeup

Municipal treated water is satisfactory for makeup and maintenance. However, water that has been treated to remove or lower the concentration of impurities is recommended. It is the responsibility of the user to determine the acceptability of the water to be used. Regardless of the water used, the requirements of the specification must be met.

1.5 Copper Contamination

To reduce copper contamination and insure that trace metals are not leached into the LHE Zn-Ni solution components must not be left in solution for more than 5 minutes without current being applied.

1.6 Amp Hours

Total accumulated Amp-Hrs for each LHE Zn-Ni tank shall be continuously recorded because this measurement is used for plating tank solution maintenance.

2 EQUIPMENT

2.1 Tanks

Tanks must be a rigid, non-metallic material such as PVC, CPVC, or polypropylene. Steel tanks may be used provided they are lined with one of the above or similar materials. Prepare the plating and conversion coat tanks for first use by leaching with a 10% water solution of hydrochloric acid (10 liters of concentrated hydrochloric acid per 100 liters of solution) circulated within the tank for several hours. Drain and rinse thoroughly. Following this step, leach the zinc-nickel tank with a water solution containing five liters of 50% weight/weight sodium hydroxide per 100 liters of solution circulated within the tank for several hours. Drain and rinse thoroughly.

2.2 Anodes

Nickel 200 anodes. Nickel 200 is an alloy containing 99.0% minimum nickel (reference ASTM B 160 for the chemical composition of Nickel 200 (listed as Nickel UNS 02200)). The anodes are insoluble. Sulfamate nickel plated steel anodes may be used for tank anodes but care must be taken to make sure the nickel is completely non-porous and that there is no exposed steel. It is required to check for pinholes on the anodes periodically (see latest vendor tech sheet for procedure). Do not use electroless nickel plated steel as an anode.

2.3 Pumps/Filtration

Pump and filtration equipment capable of at least three solution turnovers per hour. Filter elements rated at 20 - 50 micrometers.

2.4 Carbon Treatment

A method to carbon treat the plating solution external to the plating tank.

2.5 Carbonate Removal

Equipment to cool the LHE zinc-nickel solution sufficient to precipitate the carbonate and remove it from solution.

2.6 Toshi Cell

500 ml Toshi cell (a modified Hull cell).

2.7 Amp-Hour Meter

Meter that measures the total accumulated amp-hours of the LHE zinc-nickel plating solution is required to facilitate maintenance of the LHE zinc-nickel solution.

3 SOLUTION OPERATION AND MAINTENANCE

3.1 Zinc-Nickel Solution

a. Fill the tank approximately one-half full with de-ionized water. Add sufficient sodium hydroxide to achieve 90.7 grams per liter of final solution volume. **ADD THE SODIUM HYDROXIDE SLOWLY WITH AGITATION. DO NOT USE AIR AGITATION** as this will create excess carbonate.

b. Cool the solution to less than 50 °C (120 °F) and add 12.8 milliliters of Dipsol NZ-777 per liter of the final solution.

c. Cool the solution to less than 30 °C (85 °F) and add 192.3 milliliters of Dipsol IZ-C17+MS per liter of the final solution to achieve 300 grams of IZ-C17+MS per liter of final solution volume. IZ-C17+MS also contains sodium hydroxide. This should increase the sodium hydroxide concentration to approximately 120 grams per liter of final solution volume.

d. Add 21.4 milliliters of Dipsol IZ-C17+B per liter of final solution.

e. Add 4 milliliters of the water conditioner F-0529, per liter of the final solution.

f. Analyze the solution and make any adjustments necessary. For a new solution, the component concentrations should be as follows:

Sodium Hydroxide: 110 – 130 g/L
Zinc: 7 - 9 g/L
Nickel: 1.1 – 1.4 g/L
IZ-C17+B: 50 - 80 g/L

g. Place a 500 ml sample of the solution in a 500 ml Toshi cell. Plate a Toshi cell panel for 20 minutes at 4.0 amps. Maintain the solution temperature between 20 – 28 °C (68 – 83 °F). Assure that the plating is normal. The deposit should exhibit a uniform gradation of color from a dark gray through light gray to no or little visible coating. There shall be no dark deposits in the low current density portion of the panel. There shall be no streaking or odd colored bands present on the panel . If irregularities in plating quality are present, analyze the solution and make corrections as needed. After adjustments are made, plate another Toshi cell panel and review the plating quality.

Filter the solution continuously through filter media rated at 20 - 50 micrometers or smaller maintaining a minimum of three turnovers per hour. DO NOT USE AIR AGITATION. Air agitation will cause a rapid rise in carbonate. It is important to maintain good solution flow over the part in order to achieve the desired plating rate. However, there is such a thing as too much circulation. At some point, the shear effects at the solution surface due to the circulation can lead to an increase in the carbonate concentration.

3.2 Zinc-Nickel Solution Maintenance

3.2.1 Zinc

7 – 9 g/L.
Zinc is added using a zinc generator, zinc anodes, or by adding NZ-777. When adding NZ-777, consideration must be given to the sodium hydroxide present in the NZ-777 product.

3.2.2 Nickel

1.1 – 1.4 g/L (see also the zinc to nickel ratio requirement).
Nickel anodes are insoluble. Nickel is added by the addition of IZ-C17+NI. Add IZ-C17+NI as required by analysis. IZ-C17+NI may also be added on a semi-continuous basis at the rate of 1000 milliliters per 1000 amp hours of plating time.

3.2.3 Zinc to Nickel Ratio

5.7 to 8.1

3.2.4 Sodium Hydroxide

110 - 130 g/L.

3.2.5 IZ-C17+B

50 – 80 g/L.
Add IZ-C17+B as required by analysis or, alternately, at the rate of 80 mls per 1000 amp hours of plating time.

3.2.6 F-0529

Add F-0529 at a rate of 8 mls per 1000 amp hours of plating time.

3.2.7 Sodium Carbonate

Maximum of 60 g/L

3.2.8 Impurities

Chromium	<1 mg/L
Cobalt	<1 mg/L
Copper	<1 mg/L
Lead	<0.5 mg/L
Iron	<100 mg/L
Tin	<10 mg/L

a. Dummy plating at a cathode current density of 20 to 60 ASF with an anode current density above 80 ASF may decrease the lead, copper and tin. For the remaining contaminates and for lead, copper, and tin if dummying does not work, either discard a portion of the solution and remake the volume removed or remake the entire bath.

b. Organic Contaminates: Organic contaminates may be removed by carbon filtration. Carbon filtration has negligible effect on the IZ-C17+B and F-0529 components. The organic decomposition products are carbon sensitive and can be removed.

3.2.9 Periodic Dilution and Remake of Solution

The plating solution needs to be diluted periodically to remove buildup of degradation products. A 20% portion of the solution shall be discarded and remade when the bath reaches 50 amp-hours/L (amp hours/ liter) and every 25 amp-hours/L thereafter.

3.2.10 Plating Speed & Plating Time

The plating rate will slow as the solution ages. Users will need to develop a method to evaluate the plating rate. This method could be a test using a unique test specimen and fixture or, alternately, could use the measured thickness on production parts. Increase the plating time incrementally as measurements indicate a reduction in plating rate. Determine the plating rate on a schedule that will assure the required plating times are known to achieve the desired deposit thickness.

3.2.11 Toshi Cell Criteria

A Toshi cell (modified Hull cell) analysis may be used to evaluate the coating. The Toshi cell data is not definitive. The test panel should be compared to standard test panels prepared with known solution variables. This data should be used in conjunction with other analytical data to evaluate the solution.

3.3 Trivalent Chromium Conversion Coating Solution

a. Fill the tank approximately one-half full with water. With agitation, add IZ-264 equivalent to 80 mls of IZ-264 per liter of final solution.

b. Continuing the agitation, add IZ-264T equivalent to 40 mls of IZ-264T per liter of final solution. A precipitate will form when the IZ-264T is added to the water. Continue vigorous agitation. The agitation can be provided either by air or mechanically.

c. Fill the tank to working volume. Continue vigorous agitation for a minimum of 1 hour. Filtration through filter media rated at 50 micrometers or smaller can be used in addition. If using filtration the precipitate will filter out. Vigorous agitation can be terminated any time after 1 hour allowing the pumped filtration process to provide the solution circulation. If filtration is not used other means of agitation must be provided.

d. Adjust the pH to 4.0 to 4.4 using either sodium hydroxide or nitric acid as required.

e. Operate at 23 – 30 ℃ (73 - 86 °F).

f. Continuous agitation is required using either air or mechanical agitation with filtration (50 micrometers or smaller) at a minimum of one turnover per hour after make-up of solution is complete.

3.3.1 Trivalent Chromium Conversion Coat Solution Maintenance

a. Trivalent chromium: 1.2 – 2.6 g/L. Trivalent chromium is added as IZ-264T. Analyze on a sample filtered through a Whatman 42 filter paper or equivalent.

b. Cobalt: 2.0 – 4.0 g/L. Cobalt is added as IZ-264.

c. pH: 4.0 – 4.4. Increase using sodium hydroxide. Decrease using nitric acid.

d. Trace metals:

Iron	<100 mg/L
Zinc	<5 g/L
Copper	<5 mg/L

Hexavalent chromium : No limit on hexavalent chromium is available. However, hexavalent chromium impurities can disrupt the trivalent chromium film and result in non-uniform thickness. By extension, corrosion resistance will likely decrease.

If trace metals exceed these limits, the only correction is to discard a portion of the solution and remake the volume removed or remake the entire bath.

4 PROCEDURES

4.1 Clean and Degrease

Clean and degrease all parts as necessary prior to abrasive blast or plating.

4.2 Mask and Fixture

This may be accomplished at any convenient step as necessary. Use masking materials that will not leach into the solution such as vinyl plater's tape and clear polyethylene sheet.

4.3 Abrasive Blast

Abrasive blast parts at pressures less than 90 psi in accordance with MIL-STD-1504 using either garnet or aluminum oxide. Do not use media coarser than 100 grit. From this point on, the part must begin the plating process within 4 hours of the final abrasive blast. If the time between abrasive blast and plate exceeds 4 hours, re-blast parts prior to plating.

Optional alkaline cleaning, rinses, and dilute acid activation may be included as defined by local processing instructions provided all requirements of this specification are complied with.

4.4 LHE Zinc-Nickel Plate

LHE Zinc-nickel plate in accordance with a part specific process order as follows:

4.5 Step 1

Plate at a cathode current density of 30 to 60 ASF (45 ASF is optimum) for sufficient time (typically 25 minutes) to form a deposit that will meet the minimum thickness required for the part. Maintain the solution temperature at 20 – 26 °C (68 – 78 °F). Maintain the anode current above 74 ASF. It can range upward from this to the extent that the anode will carry the current without overheating. Failure to maintain sufficiently high anode current density will result in depletion of the nickel stabilizer.

The plating solution will slowly re-dissolve the deposit if the part is left in solution without current.

A strike can be applied at 60 to 90 ASF for up to 60 seconds, then reduce the current density back to the desired lower current density for the rest of the required plating time to achieve the thickness

It is permissible to remove a part, rinse, inspect for coverage, then return the part to the tank and plate any bare spots as necessary.

Temperatures approaching 100 degrees F will cause an increase in the plating rate, an increase in the carbonate concentration, and potential decomposition of the stabilizer (IZ-C17+B).

4.6 Step 2

Rinse in clean water. Multiple rinsing is recommended. Poor rinsing will result in a poor conversion coat. An activation/neutralization solution such as dilute hydrochloric acid (approximately 0.1%) followed by a rinse is recommended to promote a more uniform conversion coat.

4.7 Step 3

If required, conversion coat the part in the IZ-264 Trivalent Chromium Conversion Coating solution for 60 to 120 seconds. On removal of the part from the conversion coating solution, allow the part to hang in air for 25 to 45 seconds before rinsing. The purpose of this delay is to complete the conversion coat reaction.

4.8 Step 4

Rinse thoroughly. Maintain the temperature at or below 66 °C (150 °F).

4.9 Step 5

Dry the part.

4.10 Step 6

Inspect for coverage and quality.

4.11 Step 7

For parts heat treated above 180,000 psi, bake for 23 hours minimum at 190.5 ± 13.9°C (375 ± 25°F) or as specified in the part specific technical data. The bake must be initiated within 4 hours of removal from the plating solution.